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In this study, a preliminary analysis was carried out to verify if LANDSAT images could be used to define and delimit areas under process of desertification. Imagery for two different years (1973 and 1978) and two different seasons (dry and rainy seasons in 1978), were used to identify terrain morphology and vegetation cover. The analysis of LANDSAT interpretation, combined with geological and soil information obtained from published literature, allowed the identification of eleven ecological units which were classified corresponding to the degree of desertification in the study area.

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PRELIMINARY ANALYSIS OF THE POTENTIAL OF LANDSAT IMAGERY TO STUDY DESERTIFICATION

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ABSTRACT

In this study, a preliminary analysis was carried out to verify if LANDSAT images could be used to define and delimit areas under process of desertification. Imagery for two different years (1973 and 1976) and two different seasons (dry and rainy seasons in 1976), were used to identify terrain morphology and vegetation cover. The integrated analysis of LANDSAT interpretation, combined with geological and soil information obtained from published literature, allowed the identification of eleven ecological units which were classified corresponding to the degree of desertification in the study area.

1. INTRODUCTION

The transformation process of many areas from the Earth's surface into desertland is one of the main problems preoccupying ecologists today. The United Nations organized a meeting, held in Nairobi during August and September 1977, to discuss this subject.

In Brazil, several governmental agencies are interested in the study of this problem. In collaboration with this effort, a preliminary analysis was carried out to determine how LANDSAT imagery can be used to define the extent and limits of desertification.

Since every terrestrial ecosystem is vulnerable to the process of desertification, controlled by climatic conditions, surface features, type of soils and vegetation (ONU, 1977), we will characterize some of these elements in LANDSAT images.

2. CHOICE OF THE STUDY AREA

To make a preliminary study of the problem, it was necessary to choose an area which was clearly subject to the process of desertification. We chose in NE Brazil, the Xique-Xique region of Rio São Francisco. This region has an area of about 6174 square kilometers and is shown in figure 1.

The region is characterized by a climate 4a th, thermoxeroquimenic. It is also called hot tropical with accentuated droughts, with 7 to 8 months winter drought (minimum temperature >15°C). See SUDENE (1974).

In Figure 2 (Bahia, 1976), the hydrographic balance of the two locations close to the area under study, are shown. Furthermore, the strong water shortage in the period from April to October can be observed.

According to a world map of desertification published by ONU (1977), this semi-arid region has a moderate risk of desertification, where alluvial and residual top soils are subject to a wearing away and accelerated removal, resulting in linear erosion in the delta regions and/or laminar erosion or deposition on the plaines without human or animal pressure.

3. MATERIAL AND METHODS

In this work, we used images from the 4 channels of the LANDSAT MSS sensors (channels 4,5,6 and 7) corresponding to the orbit [illegible], dot [illegible]. These images were processed simultaneously on black and white paper, the contrast was low (15 levels of gray), and the scale was 1:500,000. They were taken on July 29, [illegible], on February 2, 1976, and on July 31, 1976. We also used images taken on August 16, [illegible] and stored on computer tapes. To select this material, we used a criterion based on the hydrographic balance of Morro do Chapéu and Remanso meteorologic stations (see figure 2). Through the visual interpretation of the photographs and automatic interpretation on the computer tapes, we were able to draw maps showing the location of the area as well as some geological, morphological, vegetation and soil aspects. The visual interpretation was made considering hue, texture, shape and context. The automatic interpretation was made through a supervised interactive process.

4. RESULTS AND DISCUSSION

Studying the above mentioned maps and photographs and using the method proposed by Poulson (1972), it was possible to make a map showing areas of different degrees of aridity. This map is showing in figure 3. In this figure, the caption is given in the numerical form introduced by Poulson (1972) to be used in ecology.

Below follows a short description of the ecological areas shown in figure 3.

Area 1 - It is located in the neighborhood of Itaparica lagoon and Utinga channel. According to the UNEP's definition (1977) it can be considered a desert. Its external limits are relatively stable. In the analyzed three year period, it is possible to observe an accelerated drying up of the lagoon.

Area 2 - It is located at the western side of Itaparica lagoon and is in an advanced stage of deterioration. It seems to be under the influence of the area described before, which involves it almost completely. This deterioration may be due to the poverty of the soils, and to the dryness of the area, as well as to human activity.

Area 3 - It is located on the western limits of a plateau (Chapada Diamantina). It has a heterogeneous vegetation with signs of degradation. This degradation may be caused by irregular surface features, associated with dryness and thin stony soils. This situation seems to be linked to an intense erosion, which is leaving the land bare and is a possible cause of the silting up of Itaparica lagoon.

Area 4 - It is located on the western bank of the Rio São Francisco and is characterized by recent wind action and very old dunes, which cause its fragile environment. Although a variety of vegetation types gives them some protection, there are signs of deterioration originated both from human and natural causes.

Area 5 - It is located on the floodplain of the Rio São Francisco, and characterized by a high environmental instability, due to a strong drainage and to a fragile constitution of its fluvial soils.

Area 6 - It is located in the northeastern part of the region under study, where the soils are more fertile. Its classification here is justified by the intense human activity on a fragile ecosystem. This fragility is due mainly to water shortage. The vulnerability of this area to the process of desertification is linked to the way its soil is used.

Area 7 - It is situated between the Sao Francisco's floodplain in the W and the Chapada Diamantina is located on the eastern central part of the region under study. This area has a dense vegetation with signs of deterioration in some places. This deterioration is due to a dense drainage network on an irregular surface, where the soils are thin, poor and stony.

Area 8 - It contains a portion of the Chapada Diamantina and is located on the eastern central part of the region under study. This area has a dense vegetation with signs of deterioration, in some places. This deterioration is due to a dense drainage network on an irregular surface, where the soils are thin, poor and stony.

Area 9 - It is located between Serra da [illegible] and the Chapada Diamantina and comprises the neighborhood of the Rio Verde floodplain. Although this

area is more or less protected by an arboreal vegetation called "caatinga", it shows signs of deterioration due to natural and antropic origin. Since this terrain is characterized by poor, relatively dry soils originated from basement rocks, it is very sensitive to the expansion of human activities.

Area 10 - It corresponds to the NE part of the region under study. Its relief is flat and the vegetation arboreal and shrubby. The quite fertile soils are derived from calcareous rocks. Its fraility is due to the expansion of human activity, characteristic of area 8, which surrounds it.

Area 11 - It is located on the highest parts of the chapada Diamantina and is covered by the densest vegetation of the region. Expansion of human activity may accelerate the deterioration of the landscape, since its soils are poor, thin and located in mountaineous surfaces.

From the above analysis, we may conclude that this region shows generalized deterioration on the landscape, due to both human activity and natural causes. For this season, it is highly vulnerable to the processes of desertification.

5. BIBLIOGRAPHY ABOUT BIOMASS

A good characterization of ecological unities through remote sensing requires an analysis of biomass and albedo.

The influence of biomass on remote sensing was studied by several authors. Pearson and Miller (1972) have shown the existence of a relation between the amount of green vegetation in an area, and the spectral radiance on this same area. This spectral response to the vegetal covering depends on the quantity and type of vegetation, as well as on the reflectance of the soil (See Siegal and Goetz,1977).

The most commonly used method is to find out the ratio between the values stored on magnetic tapes (CCT), channels 5 and 7 from MSS/LANDSAT (Carneggie et al., 1975) or to find the normalized difference between channels 6 and 5 (Haas et al., 1975) or only the values from channel 5 (Seevers et al., 1975) and to correlate the value found with the biomass samples from homogeneous and known classes. According to Seeves et al. (1975) we should not use data from microdensitometer readings of photographic transparencies of these signals. Pearson and Miller (1972) have shown that automatic classification with the MAXVER program, yields better results than the method of finding the ratio between the channels. Seevers et al. (1975) have shown that it is not possible to make comparisons of biomass estimates between different frames, but only in the same frame. So, it is necessary to establish reference patterns for each frame and also for each season of a year.

6. CONCLUSION

The images of the MSS/LANDSAT have proved to be helpful in the characterization of the environment when used in conjunction with information about the geology, morphology, soils and vegetation of the area under study.

It is important to bear in mind that orbital images constitute only the first stage in this kind of study and should be followed by a field check, in situ, and through airborne instrumentation. This complementary work is under way. There is more detailed project to study the influence of the vegetation in the albedo.

Finally, this paper shows the utility of the use of LANDSAT images, as a basis for a regional study, to delimit areas and to define their risk to desertification.

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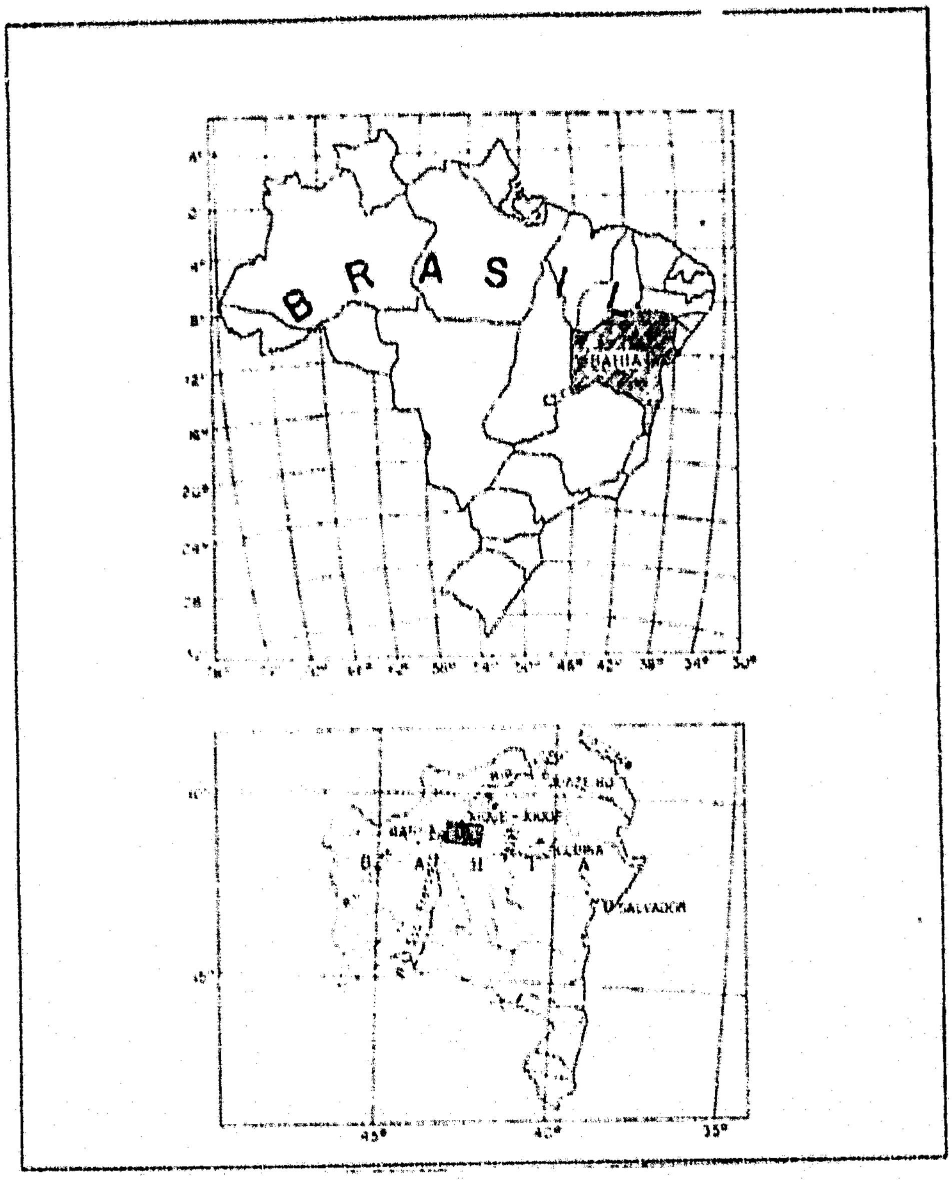

Figure 1. Location map from the studied area.

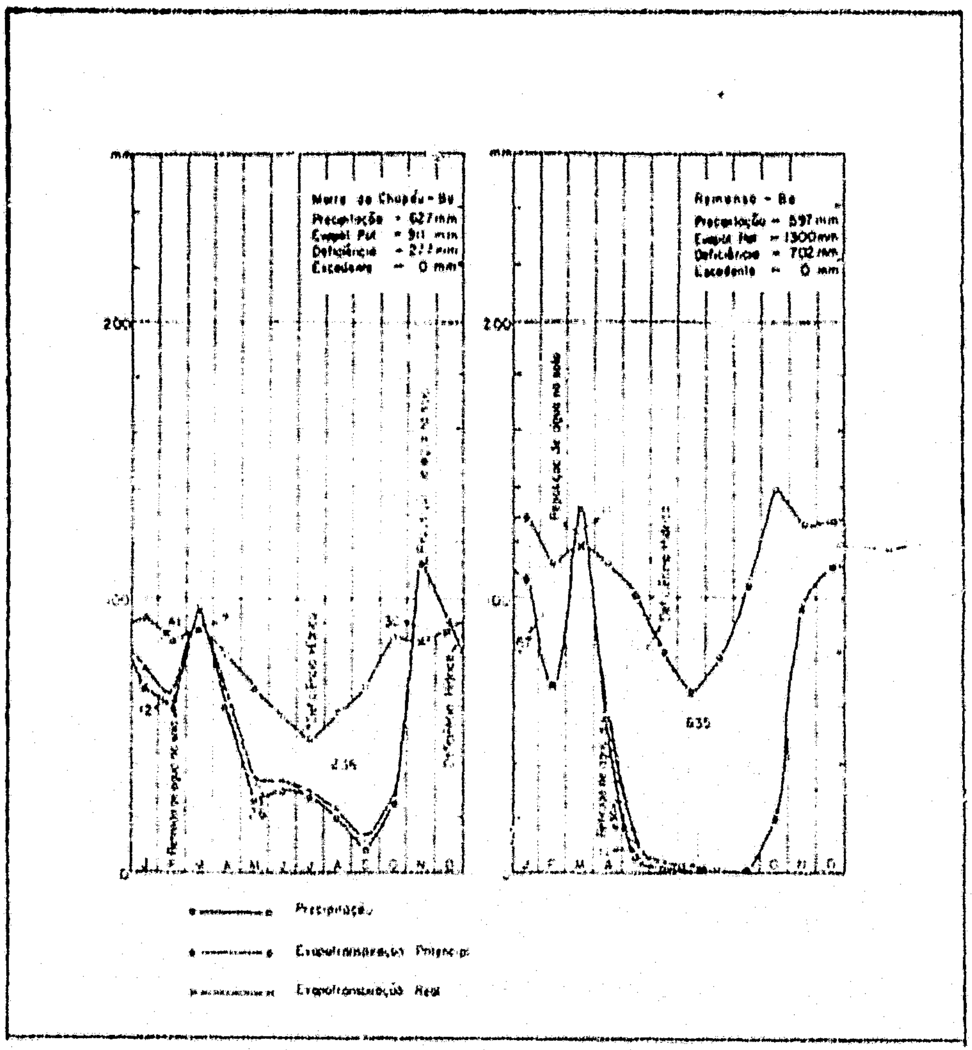

Figure [illegible]. Water balance after Thornthwaite and Mather ([illegible]) for the cities of Morro do Chapéu and Remanso (Bahia).
After BAHIA ([illegible]), fig. 13 and 14.

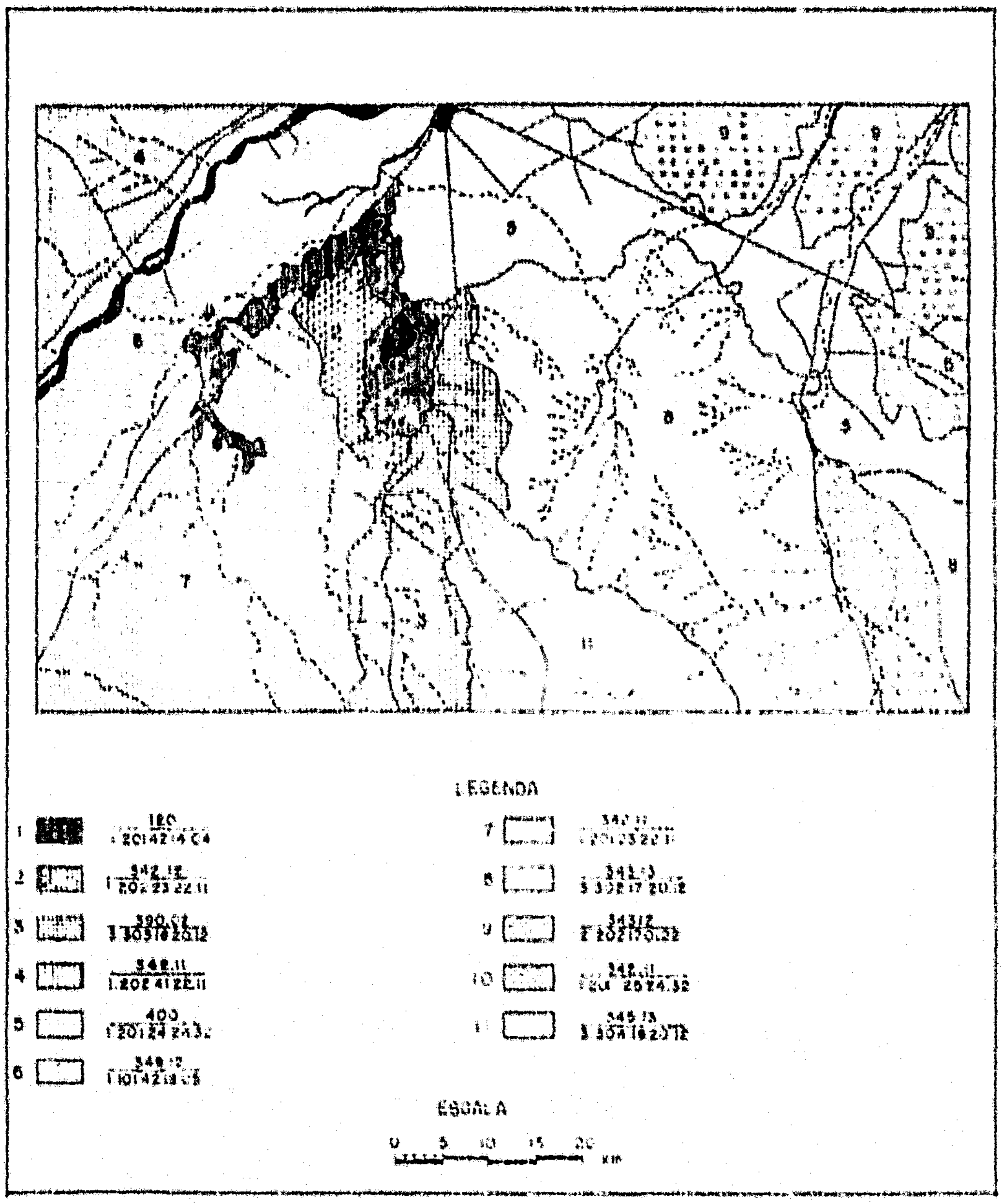

Figure [illegible]. Sketch of areas with different [illegible] of risk for desertification, in part of the Middle [illegible]